

Maturity Standards

Maturity

Maturity is the basis for determining exact moment/stage to pick a crop.

The stage at which the crops should be harvested has an important bearing on quality. Good quality is obtained when harvesting is done at the proper stage of maturity. Fruits harvested before optimum maturity may not ripen adequately and may not develop adequate flavour, while crops harvested late (over mature) will have a shorter postharvest life and will deteriorate easily.

Maturity indices

Maturity indices are the sign or indication the readiness of the commodity for harvest. It is the basis for determining harvest date.

Types of maturity

A. Physiological maturity: It refers to the stage in the development of the fruits and vegetables when maximum growth and maturation has occurred. It is usually associated with full ripening in the fruits. The Physiological mature stage is followed by senescence.

Example, A French bean pod of okra is at its physiological maturity when seeds are fully developed and the pod is which will dehisce with little pressure.

B. Horticultural/Commercial maturity: Horticultural maturity refers to any stage of development when the commodity has reached a level of development sufficient for its intended use. It is sometimes referred to as commercial maturity.

Example, A papaya with green pulp and peel that has attained maximum size in already commercially mature as a vegetable but a tinge of yellow colour has to develop when it is used for dessert.

C. Harvest Maturity: It may be defined in terms of Physiological maturity and horticultural maturity. It is a stage, which will allow fruits/vegetables at its peak condition when it reaches to the consumers and develop acceptable flavour or appearance and having adequate shelf life.

Example, For local market and for processing, fully coloured tomato fruits are harvested. However, for a distant market fruit which have started developing colour are harvested.

Determination of maturity

Maturity can be determined either by subjective or objective observation. According to Reid (2002), the methods of determining harvest maturity are as follows-

- **Physical methods:** Size, shape, colour, texture etc.
- **Chemical methods:** Total Soluble Solids (TSS), acidity etc.
- **Physiological methods:** Respiration and ethylene production.
- Apart from the above measures, abscission, accumulated heat unit, specific gravity, duration after flowering, firmness, dry matter, juice content, Oil content, waxiness, tenderness etc can also be used to determine the optimum stage of harvest maturity.

Some important measures of maturity of fruits and vegetables are described in the following-

(i) Fruit Color: Fruit skin or flesh color changes as the fruit matures or ripens. These changes can be determined subjectively by the harvester. However, color meters and color charts have been developed for determining harvest times for apples, tomatoes, peaches, chili peppers etc. However, some fruits do not exhibit any perceptible color changes during maturation and thus this parameter cannot be effectively used. Color changes also differs among different cultivars of the same fruit.

For example, the Hayward cultivar of kiwifruit maintains its green flesh during maturation while ‘Sanuki Gold’ cultivar changes gradually to golden-yellow. Some cultivars of avocado also maintain their green skin color during maturation.

(ii) Firmness: Some fruits may change in texture during maturation and these changes can be used to determine the harvest time. Textural changes are detected subjectively by touch or gentle squeezing. However, objective measurement can be achieved using pressure testers and texture analyzers.

(iii) Soluble Solids Content and Starch content: During maturation, starch in non-climacteric fruits is converted to sugars. For climacteric fruits, starch accumulates during maturation. Therefore, harvest maturity can be determined by measuring the sugar content or starch content. Usually, the sugar content is measured in terms of total soluble solids content using a Brix hydrometer or refractometer. Starch content is measured using iodine to qualitatively determine the amount of starch. This method is used in determining the maturity of pear cultivars whereby the fruit is cut into two and dipped into a solution containing potassium iodide and iodine.

(iv) **Number of days from Fruit set:** Fruit set refers to the transition of a flower to fruit after fertilization. It usually involves rapid cell division and expansion of the ovary and development of seeds. In some fruits, the time taken between fruit set until the fruit starts showing signs of maturity has been recorded and this can be used to determine harvest time. For instance, in *alpanso* and *pairi* mango varieties, it takes about 110 to 125 days after fruit set for surface color to change from dark green to olive-green and flesh color from white to pale yellow (Bhatnagar and Suramanyam, 1971). Tandon and Karla (1986) concluded that, *Langra* and *Mallika* took 84 and 96 days after fruit set respectively to attain harvest maturity.

(v) **Specific gravity:** The specific gravity of fruit can be considered as an index for maturity grading. Water has a specific gravity of 1.00 and common salt solution (2.5% NaCl) has a specific gravity of 1.02 and both are used in the maturity grading of mango fruits (Kapsa and Katrodia 1997). e.g. specific gravity of mango range between 1.01-1.02.

In summary, the maturity of fruit at harvest will greatly affect their quality along the post harvest value chain. Accurate, efficient and effective maturity indices need to be applied in order to ensure high quality at all levels along the value chain. It is worth noting that a single maturity index cannot be used to predominately determine maturity of fruits. It is advisable to use different parameters simultaneously to improve the accuracy of the determinations. Furthermore, one maturity index cannot be applied across all cultivars of the same crop. There are slight differences among the cultivars.

Differentiate between physiological maturity and horticultural maturity

Physiological maturity	Horticultural maturity
1) It refers to the stage in the development of the fruits and vegetables when maximum growth and maturation has occurred.	1) Horticultural maturity refers to any stage of development when the commodity has reached a level of development sufficient for its intended use.
2) Indicate the end of stage.	2) Indicate desirable change to make marketable.
3) Maximum growth and maturation occurred.	3) Maximum growth and maturation not occurred.
4) Closely associated with fruits.	4) Closely associated with vegetables.
5) Allow normal ripening after harvest.	5) May not ripen.
6) Seed collection easy.	6) Seed collection not easy.

Factors affecting maturity

1. **Temperature:** Higher temperature gives early maturity.e.g. Gulabi (Pink) grapes mature in 100 days in Western India but only 82 days are enough in the warmer Northern India. Lemon and guava takes less time to mature in summer than in winter. Sun-scorched portions of fruits are characterized by chlorophyll loss, yellowing, disappearance of starch and other alcohol insoluble material, increase in TSS content, decrease in acidity and softening.
2. **Soil:** Soil on which the fruit tree is grown affects the time of maturity. e.g. Grapes are harvested earlier on light sandy soils than on heavy clays.
3. **Size of planting material:** This factor in propagated fruits affects fruit maturity. e.g. In pineapple, the number of days taken from flowering to fruit maturity was more by planting large suckers and slips than by smaller ones.
4. **Closer spacing:** Close spacing of hill bananas hastened maturity.
5. **Pruning intensity:** It enhanced the maturity of Flordasun and sharbati Peaches.
6. **Girdling:** Process of constricting the periphery of a stem which blocks the downward translocation of CHO, hormones, etc. Beyond the constriction which rather accumulates above it. In Grape vines it hastens maturity, reduces the green berries in unevenly maturity cultivar and lowers the number of short berries. It is ineffective when done close to harvest. CPA has an additive effect with girdling.

Maturity symptoms of fruits and vegetables

Mango

1. Slight colour developed on the Shoulders.
2. When one or two ripe fruits fall from the plant naturally.
3. When the specific gravity of fruit ranges between 1.01-1.02.
4. Number of days taken by the fruit to mature depends on variety and climatic condition. However fruits mature between 90 to 120 days from the fruit set stage.
5. Pulp dry matter content should be at least 14%.

Jackfruit

1. When the fruit is mature, the spokes of the rinds become flat and the tips become black.
2. The other indices used are density of latex. Watery latex at harvest maturity and concentrated white milky latex at immature stage.
3. Metallic sound on striking the fruit with a finger indicates in mature stage whereas dull sound indicates mature fruits.
4. More space in between the surface protuberance.
5. In general, fruits mature between 120 to 150 days from fruit set stage.
6. Tender Jackfruit for use as vegetables should be harvested until the seeds harden.

Pineapple

- In general, harvesting for local markets should be done at the full maturity stage and for distant markets at 70 to 80% full green or with light colour beak stage.
- The lowermost eyelets in the variety *Gaint Kew* show; orange yellow color and eyes get flattened in the centre and bulge on the sides. While *Honey Queen* variety is harvesting at-
 - ✓ M1- Fruit turning yellowish at the base,
 - ✓ M2- Fruit is coloured up to half of its height. i.e. 25 to 50% yellow,
 - ✓ M3- Fruit is coloured more than half of its height. i.e. more than 50% yellow.

For local consumption, harvesting is mostly done at M3 stage and for long distance distribution harvesting takes place usually at M1 and M2 stage depending on the buyer's choice.

Banana

1. The fruit should be harvested when the ridges on the surface of the skin change from angular to round. i.e. after the attainment of 3/4th full stage.
2. A bunch is usually takes 90 to 120 days to mature after emergence of inflorescence, depending on the climate and variety.
3. The floral part at the top of the fruit should be dried up and the base of the bunch should be changed in colour from Dark green to light green.

Litchi

1. Generally takes 55 days after fruit set for reaching optimum maturity.
2. Flatness of tubercles and smoothness of pericarp.
3. Fruit colour changes from Green to Pink on maturity.
4. At optimum maturity stage, the fruit should have 18.1° Brix TSS, 0.24% acid and 1.00 specific gravity.

Papaya

1. Mature green fruits should be harvested for vegetable.
2. Peel colour changes from Green to yellowish green for dessert.
3. Latex of the fruit becomes watery.
4. The first fruits would be harvested 12 to 14 months after transplanting.
5. Fruits for local market can be harvested when they are half ripe.

Okra

1. Desirable size of the Pods attained.
2. The tips of the pods can easily be Snapped.
3. The tender young fruits of 7 to 10 cm long should be harvested every alternate day.
4. The pods of okra become ready for harvest from the 6th day of flowering.

Eggplant

1. Desirable size and colour attained.
2. Skin should be bright and glossy. Over mature fruits are dull, seedy and fibrous.

Tomato

- It depends on the purpose for which they are used and distance over which they are to be transported. The following stages of maturity for harvesting have been recognised-

► **Immature:** before the seeds have fully developed and before the jelly like substance surrounding the seeds have formed.

- ▶ **Mature green:** seeds are surrounded by jelly like substances filling the seed cavity. The fully grown fruit shows a brownish ring at stem scar.
 - ▶ **Breaker stage:** 1/4 of the surface at Blossom end shows pink.
 - ▶ **Pink:** 3/4 of the surface shows pink.
 - ▶ **Hard ripe (Red ripe):** nearly all red or pink but flesh in firm.
 - ▶ **Over ripe:** Fully coloured and soft.
- For long distance transportation should be picked at mature green stage and ripened after reaching the market.
 - **For processing:** Fully ripe to ensure desired quality and red colour in product.

Cauliflower

1. Desirable size attained.
2. Cauliflower should be harvested at the stage when the curd is compact.
3. Over mature curd becomes loosened with elongated flower cluster.

Harvesting

Definition: Harvesting in the process by which agricultural commodities are detached from their mother plants for consumption or sale or for other purposes.

Or, Harvesting is the deliberate picking of the commodity from the plants.

Harvesting indices: It refers, the economic yield of a crop in comparison with the actual total yield. For the determination of optimal harvesting maturity, it is a necessary tools and for this maturity indices should be known.

Harvesting of fruits should be done at optimum stage of maturity. During harvesting operation, a high standard of field hygiene should be maintained. It should be done carefully at proper time without damaging the fruits. The harvesting operation includes.

- Identification and judging the maturity of fruits.
- Selection of mature fruits.
- Detaching or separating of the fruits from tree.
- Collection of matured fruits.

Method of Harvesting

Different kinds of fruit and vegetables require different methods of harvesting. The methods of harvesting are:

1. Manual Harvesting.
2. Mechanical Harvesting.

1. Manual Harvesting: Harvesting by one's own hand is called manual harvesting. Hand harvesting has a number of advantages over machine harvest. People can accurately determine product quality, allowing accurate selection of mature product. This is particularly important for crops that have a wide range of maturity and need to be harvested several times during the season.

It is done in several ways:

- a. Ladder/bag picking method.
- b. Poles/Clippers method.
- c. Harvesting by means of cutting knives.
- d. Harvesting by means of digging tools.

2. Mechanical Harvesting: In this method, numbers of mechanical devices are used for harvesting the produce on commercial scale. Mechanical harvest is currently used for fresh-market crops that are roots, tubers, or rhizomes and for nut crops. Vegetables that are grown below ground (radishes, potatoes, garlic, carrots, beets and others) are always harvested only once and the soil can be used to cushion the product from machine caused mechanical injury. Tree nuts and peanuts are protected by a shell and easily withstand mechanical handling.

Points to be considered during harvesting of horticultural crops

1. Produce should be collected with care to avoid injury and damage.
2. Market demands in terms of size and stage of maturity should be considered.
3. Containers and harvesting tools should be clean and free from rough edges.
4. Stackable and nestable plastic crates should be used as field containers during harvest. Plastic crates are durable, reusable and can easily be cleaned.
5. The harvesters should be properly trained on harvesting methods and proper stages of maturity.

6. Produce that has fallen or touched the ground should not be harvested.
7. Shade should be provided over the harvested produce to prevent heat and sun damage and reduce the rate of nutrient degradation.
8. Suitable time of harvesting horticultural produce is the early morning.
9. The harvesting tools and equipments should be disinfected with chlorine water.

Effects of maturity on physico-chemical changes and ripening

Harvest maturity has a great influence on the post harvest quality of fruits and vegetables. For example, Mango fruits harvesting at mature and have mature stages produced good quality characteristics when ripened at 25°C. The mature fruits are observed to have faster rate of ripening compared to the half mature and immature fruits. The immature fruit only showed limited quality changes during ripening and normal physico-chemical changes did not fully occur.

Chemical composition

Chemical changes are often used in determining the maturity of mango fruit for harvest. Total soluble solids, starch, Sugars, total carotenoid pigments and pH are correlated positively with mature; whereas moisture content, acidity, ascorbic acid and tannins are correlated negatively.

Rate of respiration

The rate of respiration of mango fruits varies with variety stage of maturity and ripening. Respiration attains at its maximum at the ripe stage compared to the unripe and senescent stage.

Ethylene production

In general, the rate of Ethylene production remains lower in the preclimacteric phase and increase considerably in the climacteric phase. Mature and half mature fruits showed higher rate of ethylene production, ripened normally and maintained acceptable flavour and aroma when compared with immature fruits. Ripening of the immature fruits was insufficient as revealed by low ethylene production, poor colour development, minor changes to fruit composition, insipid flavour and poor aroma. Although the rate of Ethylene production remained low during the later stages of maturation, a peak in ethylene production was observed about 10 days prior to harvest maturity.

Rate of ripening

Fruit ripening also depends on the stage of maturity at harvest. Ripening of mango fruits at low temperature was effectively retarded in the immature fruits compared with mature fruits of the variety '*Amelie*'. In contrast, the variety '*Sensation*' ripened rapidly irrespective of harvest maturity. When the mature fruits were ripened at 25°C, they failed to develop the characteristics of full ripeness. Exposure of mature and half mature fruits to acetylene (1.6 mL/L) and ethylene (1.0 mL/L) for 8 hours resulted in the initiation of full ripening, whereas mature fruits failed to fully ripen.